

Exhibit F

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AUTOS

The brutal and extreme tests Ram, Ford, Chevy run on trucks



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In the summertime, Mark DenUyl of Marysville loads thousands of pounds of busted-up concrete into his trailer and hauls it behind his Ford F-350 pickup, which is filled with construction equipment while driving over pothole-filled roads for weeks at a time in temperatures exceeding 90 degrees.

When winter comes, he and the F-350 will pull 36-hour shifts in blizzard conditions, pushing snow into piles up to 5 feet high.

That's nothing.

Because car companies “torture test” their trucks — driving them over ice-covered lakes in 40 degrees below zero and through deserts topping 130 degrees. Breakdown is not an option.

Whether it’s the Ford F-Series, Ram 1500, Toyota Tundra, Chevrolet Silverado or others, companies globally are testing full-size pickups and midsize pickups more aggressively than ever.

Ford uses the slogan “Built Ford Tough” and has long dominated full-size pickup sales in North America. But customers expect every truck to withstand assault.

“We load a truck up, put on a trailer, accelerate from zero to 95 mph, hard brake, and repeat that time after time after time,” said Mike Raymond, chief engineer for the Ram 1500. “We drive in heavy rain with washed-out gravel roads that create trenches a lane-width wide. We run the front wheels into the trenches and slam on our brakes to get the worst-case shock-loading experience on our suspension. We drive roads that could eat an entire wheel, and do it all day long.”

Fiat Chrysler has test roads at proving grounds that replicate notorious highway sections in North America. Such areas are then nicknamed, including Chalma Road at Chelsea Proving Grounds in Michigan, which imitates rough areas of Mexico.

Imagine abusive roads and couple them with abusive drivers.

“We have to make sure the truck doesn’t overheat or freeze up. This is about completing a mission,” Raymond said. “We’ll chase temperatures in the northern states and Alaska, look for minus 40 degrees and minus 60-degree days. We all dress in Carhartt overalls and cold weather gear with 6 inches of insulation.”

He continued, “Then we’ll run trucks through slush pits and see if they can survive. Run it through, let it freeze sitting overnight. Ice melts, go back into the pool. Freeze the underbody again. Then we’ll run trucks nose-to-tail all in a row so they ingest snow into every orifice to assure the engine can still breathe. You have to be able to drive in a blizzard.”

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And then there’s the mud pack.

“We drive the truck into a pool of mud, cake mud all over the vehicle, and make it basically 2,000 pounds heavier. You have a ton of mud. Literally,” Raymond said. “Let it dry. Layer it again. Let it dry. Then you have to clean the damn thing off, so we get a power washer. Can it handle that?”

Ram engineers strap mannequins filled with water into the vehicle seats to imitate wear and tear on the seats and seat belts.

“We panic-hit brakes, and you can feel a nose dive, where the weight transfers to front springs and axle,” Raymond said. “Then we simulate 10 years of corrosion in six months, soaking the trucks in salt and brine in humidity chambers. Corrosion testing is also done in Halifax, Nova Scotia.”

36,000 miles nonstop

Ram trucks get 36,000 miles of nonstop driving — from northern Minnesota cold to Denver for elevation to Las Vegas to chase heat to Florida for the humidity. That looks at the warranty

cycles. At the end of the day, the new Ram 1500 will have 6 million miles of equivalent testing.

That doesn't even include the Electromagnetic Capability (EMC) testing, which attempts to disrupt the software or electrical network in the truck, Raymond said. "We bomb the truck with electromagnetic signals to see if anything interferes with the electronics."

The Ram 1500 spends 20 days, 24 hours a day being road tested at the proving grounds alone.

Toyota takes its trucks from the mountains of Japan to the brutal 4x4 trails near Moab, Utah, through the blistering roads of Death Valley to the frigid roads of Alaska during the winter.

"We try to figure out how somebody might use these and maybe misuse them. We can break just about anything," said Sheldon Brown, chief engineer for research and development, working on the Toyota Tacoma.

"A small child might move from the front seat to the back, and climb over the center console. What kind of load is that? Those types of things you can't define. Or let's talk about a three-piece bumper. Drivers back up trucks a lot, trailering and going off road, and every once in a while people may back into an obstacle or drag a bumper on a steep off-road trail. Rather than replace the entire bumper, we can make it so you only replace a portion. This is about how vehicles get used in the real world."

From subfreezing temperatures to deep desert sands, engineers try everything.

"In order to be sure the product is going to perform the way consumers demand, car companies have to test," said Stephanie Brinley, principal analyst at IHS Markit. "Talking about it, that's about building confidence with the consumer that the products will, in fact, perform as advertised."

Robot test dummies

Ford uses driving robots to withstand more aggressive, repetitive punishment human bodies cannot, said Aaron Bresky, Ford F-Series Super Duty truck vehicle engineering manager. "We have to keep upping our testing game."

The Ford Ranger spends days hooked up to a four-post shaker table to check for squeaks and rattles. This follows a run up the steep grades of the Davis Dam in Arizona and hot dusty terrain of the Australian Outback.

And the Ford Raptor, which drives a 65-mile rough course through sand washes and silt beds in the California desert, has increased its speed from 35 mph to 50 mph.

Engineers at Ford say five days of some repeated testing is equal to 10 years or 150,000 miles of use.

“I pull as much as I’m allowed legally. I truly push my trucks to the limit,” said DenUyl, a construction company owner who expects delivery of his 2019 Ford F-350 on Dec. 22.

He already has a Ford F-150, two F-350s and a Ram 2500.

“My biggest worry is trucks going down during plow season. Every hour counts. If I’m trying to bill \$150 an hour, for any hour the truck goes down, I am totally out. The snowstorm only lasts so long; you have to make money when the snow falls,” said DenUyl, a husband and father of three. “And that’s when I’m pushing the hardest — the transmission and the brakes.”

For Ford, GM and Fiat Chrysler, full-size pickups are among the most profitable vehicles in the portfolio. According to IHS Markit data, they accounted for nearly 35 percent of Ford’s U.S. sales in 2017, compared with providing 27 percent of GM’s U.S. sales and 24 percent of FCA’s U.S. sales.

The 2019 F-150 is an update, going up against completely new Ram and Silverado models. It’s the first time in memory that two of the top three trucks have been all new in the same model year, intensifying competition to a new level.

GM’s GMC Sierra luxury truck sells in smaller numbers — No. 17 in overall U.S. vehicle sales last year — but it’s brand new, too.

In raw numbers, the F-Series has an unassailable lead. Ford sold more than 896,000 F-Series trucks last year, the 41st year it was the best-selling truck and the 36th year it was the top selling vehicle overall.

In 2017 through August, Ford sold 576,334 F-Series while GM sold 363,354 Silverados and Fiat Chrysler sold 327,759 Rams.

By the same time this year, Ford sold 603,926 full-size trucks; Silverado sold 378,731 and Ram sold 323,727.

Ford grew its market share. GM grew its market share slightly. Ram slipped a bit.

Not for commuting

John McElroy, a longtime industry observer and host of Autoline.tv, emphasized that trucks are often used for punishing work and not just commuting.

“Companies weigh them down and drive them over rough roads while hauling maximum capacity trailers,” he said. “The engines can’t overheat and brakes can’t wear down. They’re put through a lot more smashing and bashing and more miles than any passenger car.”

Every company brags about their truck torture tests, but all testing is pretty comparable at this point, McElroy said.

"My guess is the general public doesn't know much about the extent to which automakers test their trucks, even before they started using robots," he said. "I mean, they would have these sorts of mechanical arms that would open and slam car doors, and they did this for weeks. Then they'd have a test with a plunger coming down, like with a human butt, smashing into seat and twisting back and forth. They do this a million times."

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